Studies of ATLAS Very Forward Detectors

DESY Summer Student Program 2007

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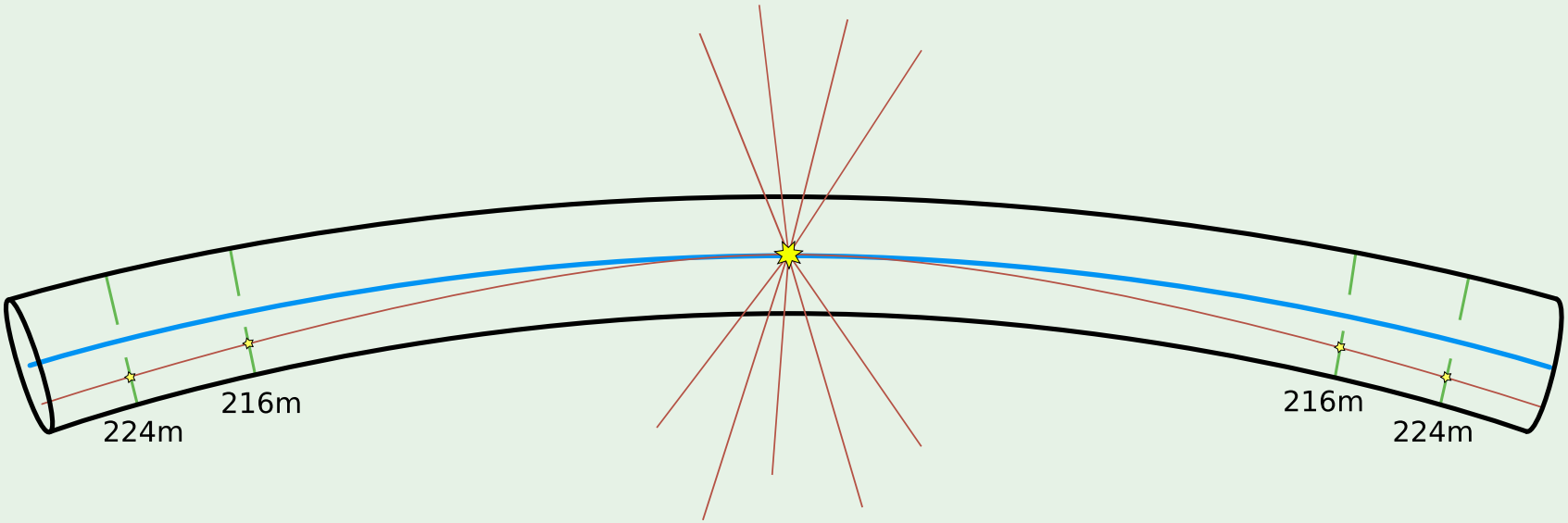
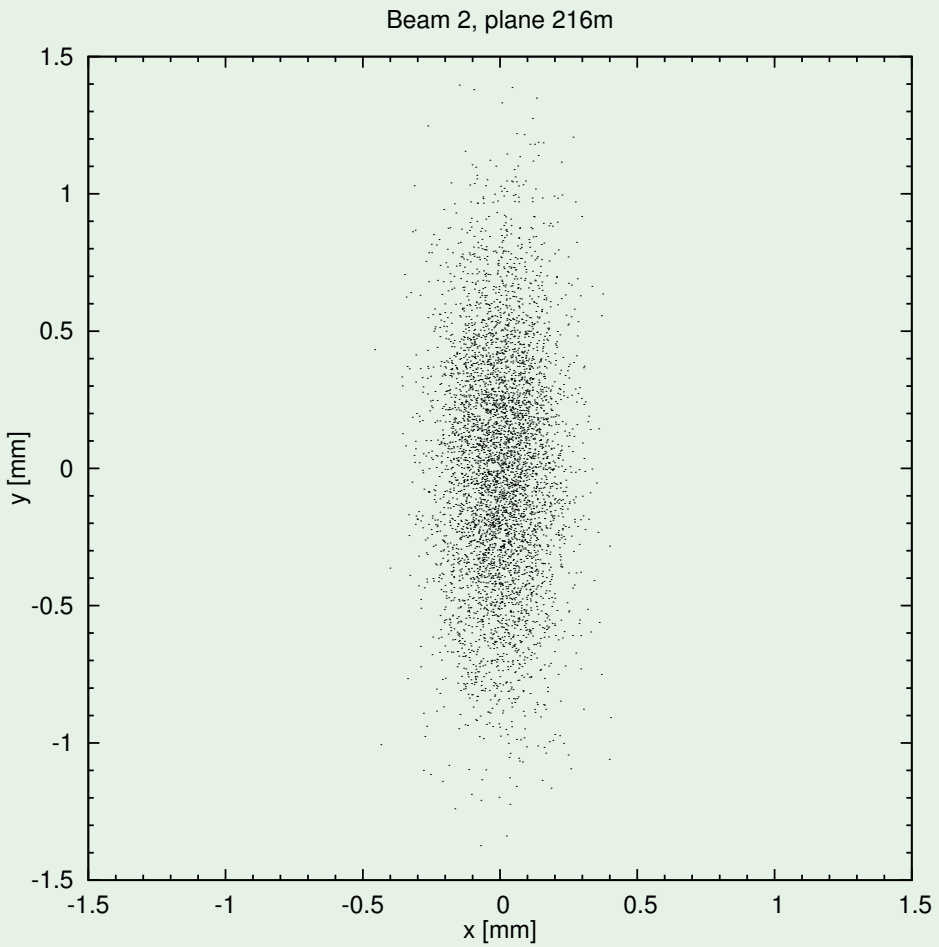
Atlas "220 m" forward detectors



Example



Beam at IP

$$\sigma(x_0) = 16.6\ \mu m$$
$$\sigma(y_0) = 16.6\ \mu m$$
$$\sigma(x_0') = 30.2\ \mu rad$$
$$\sigma(y_0') = 30.2\ \mu rad$$
$$\sigma(E) = 0.77\ GeV$$

Beam 2 at 216 m

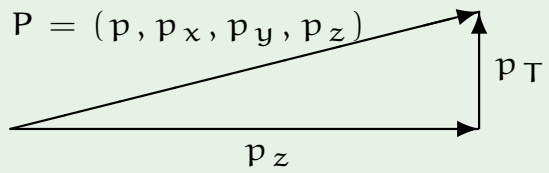
$$\sigma(x_0) = 117\ \mu m$$
$$\sigma(y_0) = 407\ \mu m$$

Before interaction

$P_0 = (p_0, 0, 0, p_0)$

$(p_0, 0, 0, -p_0)$

After interaction



Definitions

$$p = \sqrt{p_x^2 + p_y^2 + p_z^2}$$

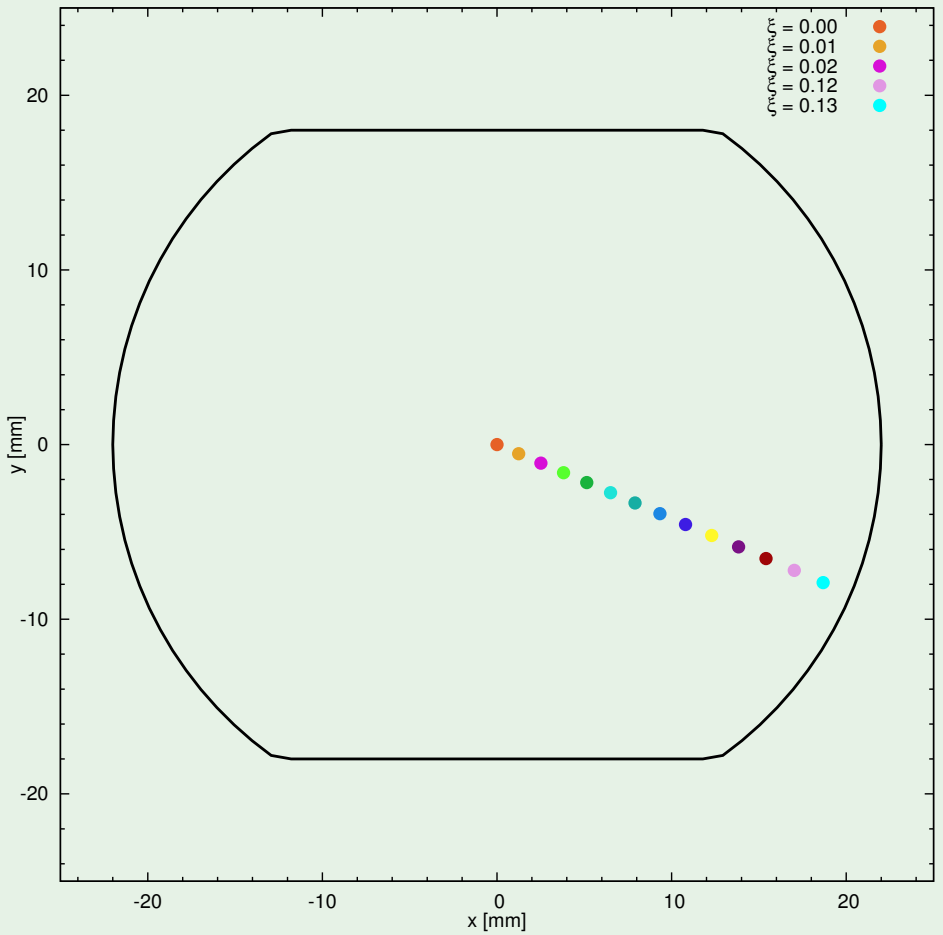
$$p_T = \sqrt{p_x^2 + p_y^2}$$

$$t = (P_0 - P)^2$$

$$\xi = \frac{E_{loss}}{p_0} = \frac{\Delta p}{p_0} = \frac{p_0 - p}{p_0}$$

φ – angle between x axis and the $\vec{p}_T = (p_x, p_y)$ vector

Protons in beam 2 at 216 m

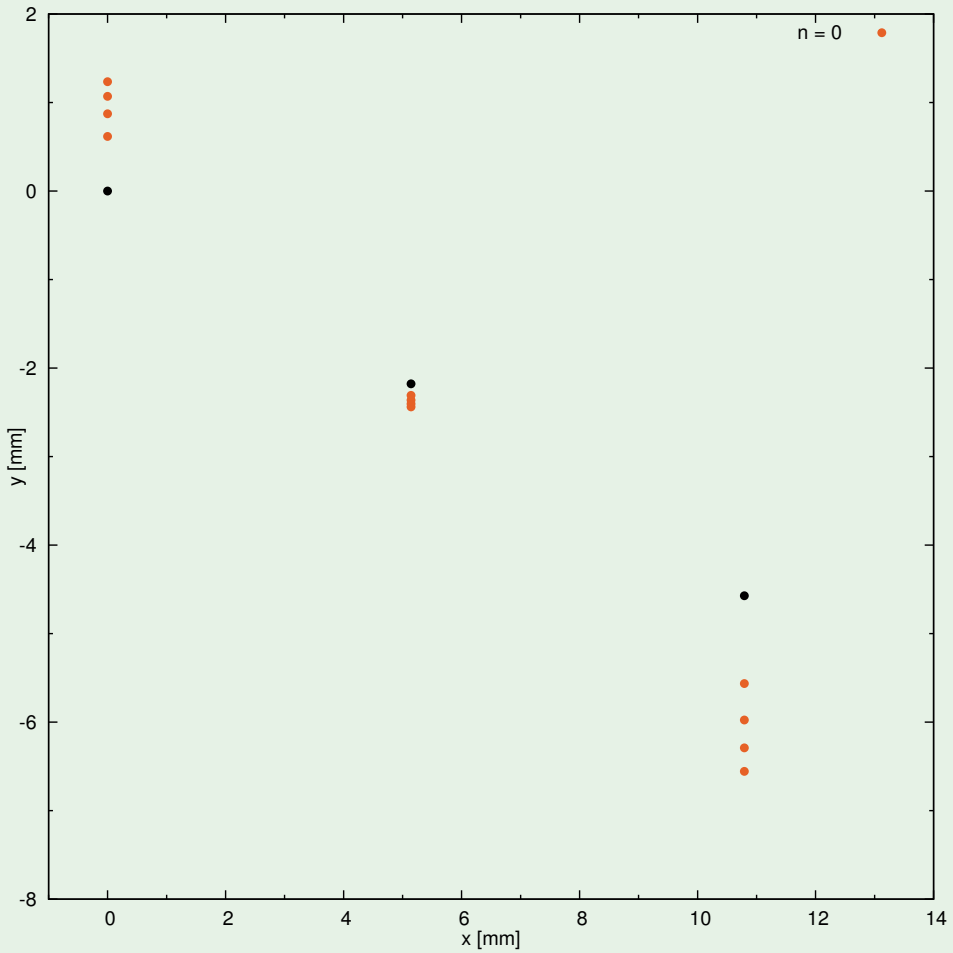


$$\xi = \frac{E_{loss}}{p_0}$$

$$\xi = 0.01$$
$$\Updownarrow$$
$$E_{loss} = 70 \text{ GeV}$$

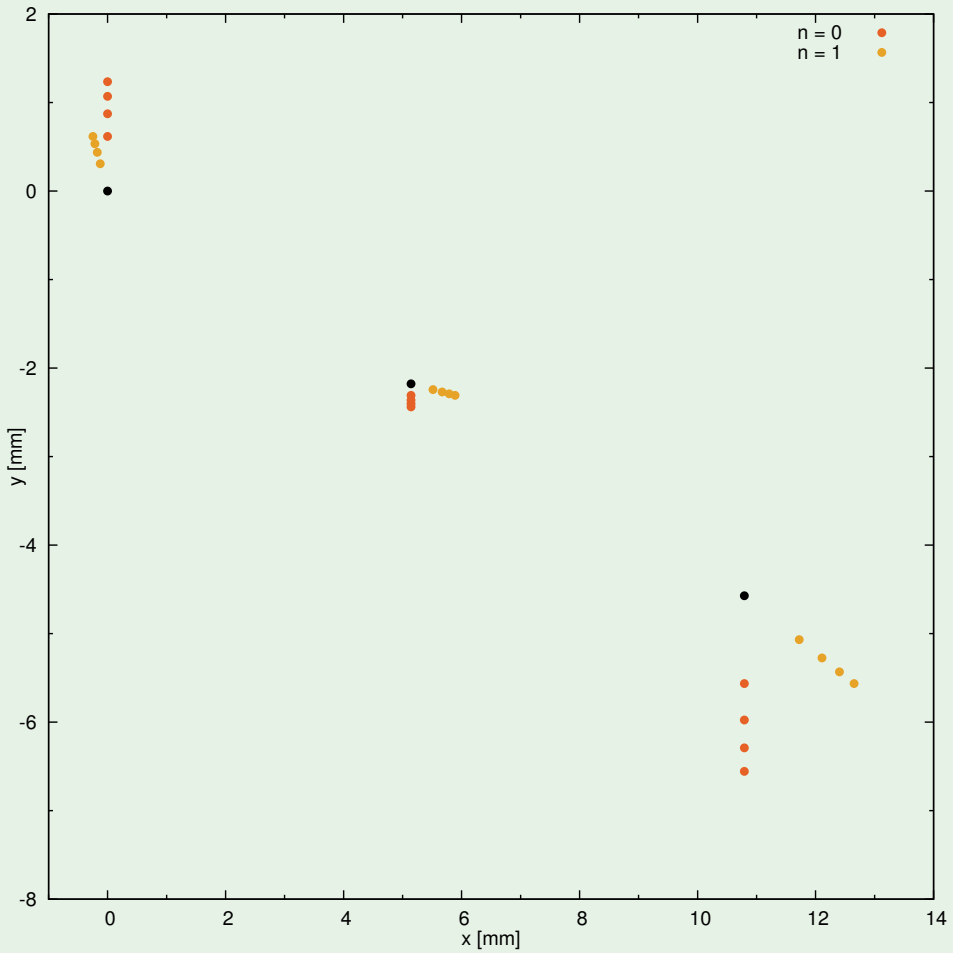
$$\xi = 0.13$$
$$\Updownarrow$$
$$E_{loss} = 910 \text{ GeV}$$

Protons in beam 2 at 216 m



$$\begin{aligned} \xi &= 0.00, 0.04, 0.08 \\ t &= 0.0, -0.1, -0.2, \\ &\quad -0.3, -0.4 \text{ GeV}^2 \\ \varphi &= 2\pi\frac{n}{6} \end{aligned}$$

Protons in beam 2 at 216 m



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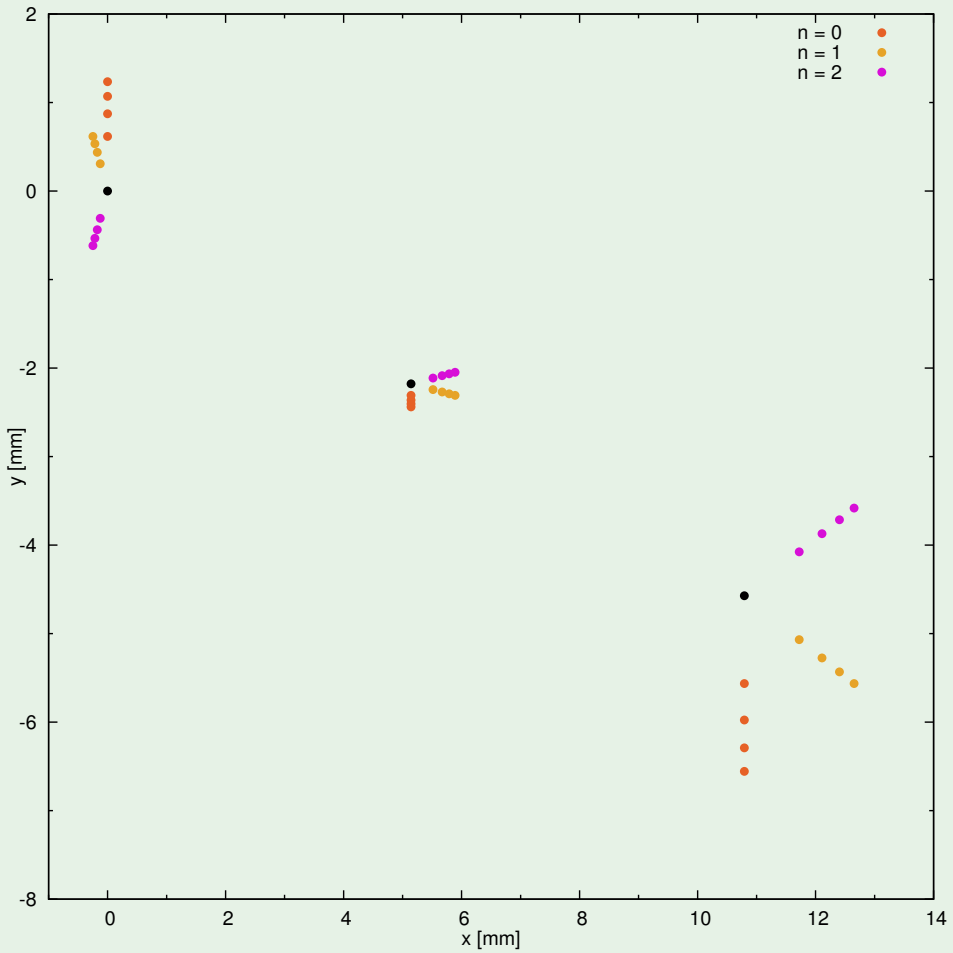

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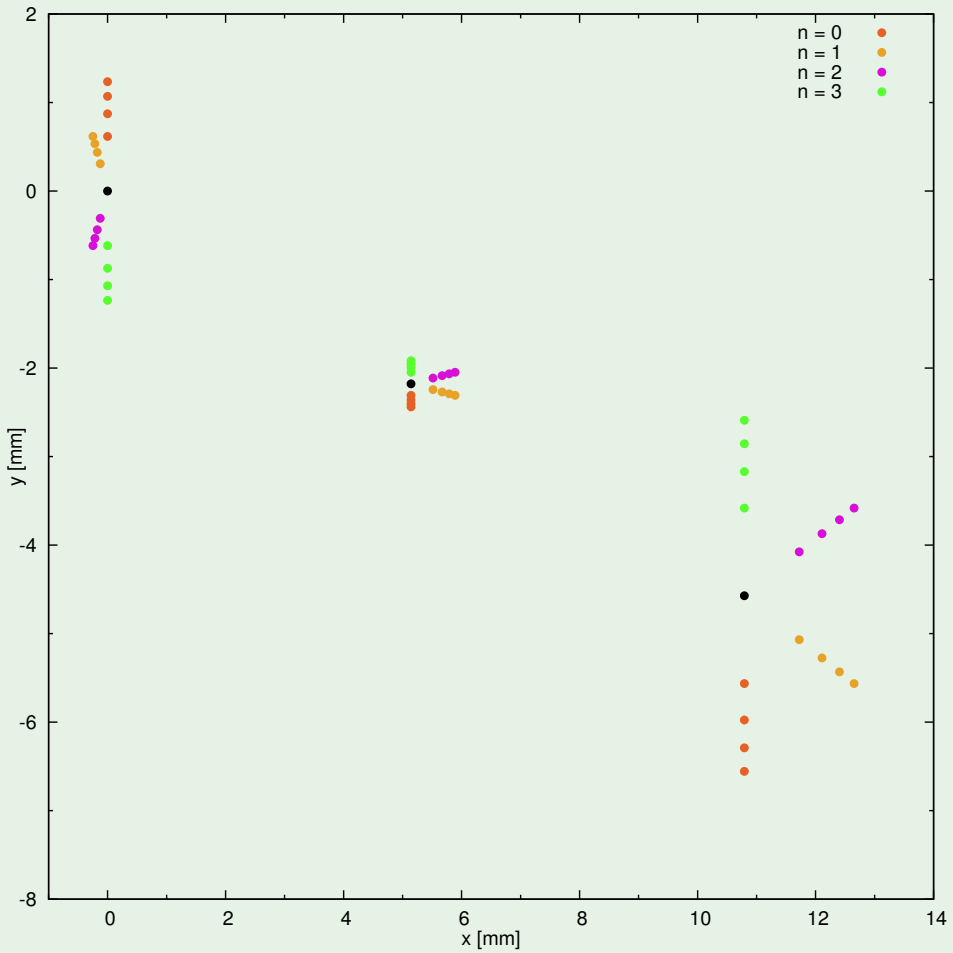

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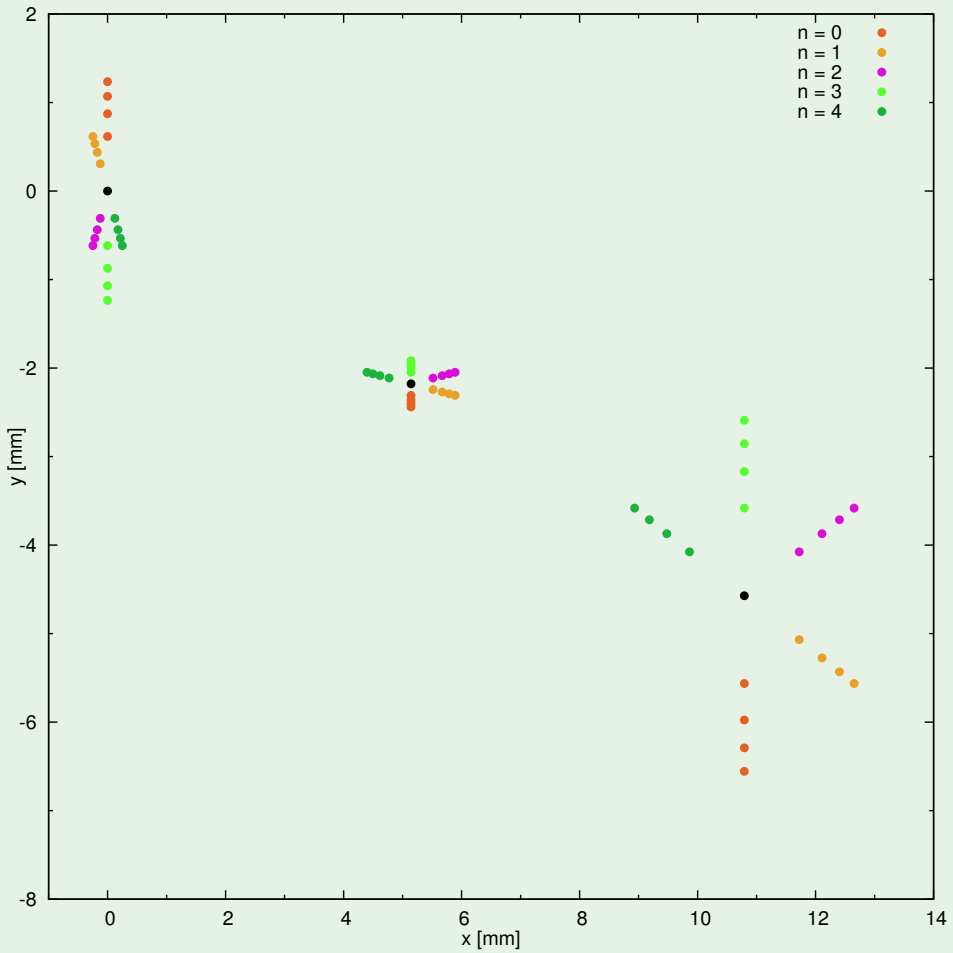

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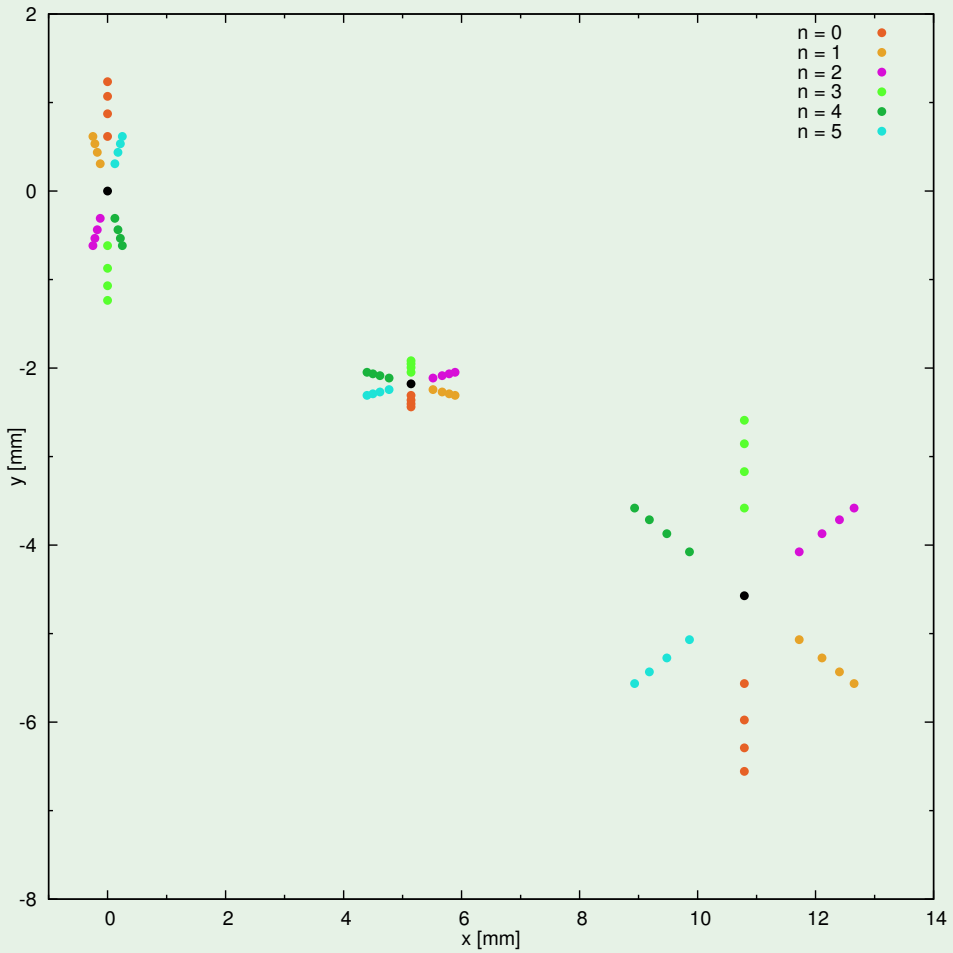
Protons in beam 2 at 216 m



$$\xi = 0.00, 0.04, 0.08$$

$$t = 0.0, -0.1, -0.2, -0.3, -0.4 \text{ GeV}^2$$

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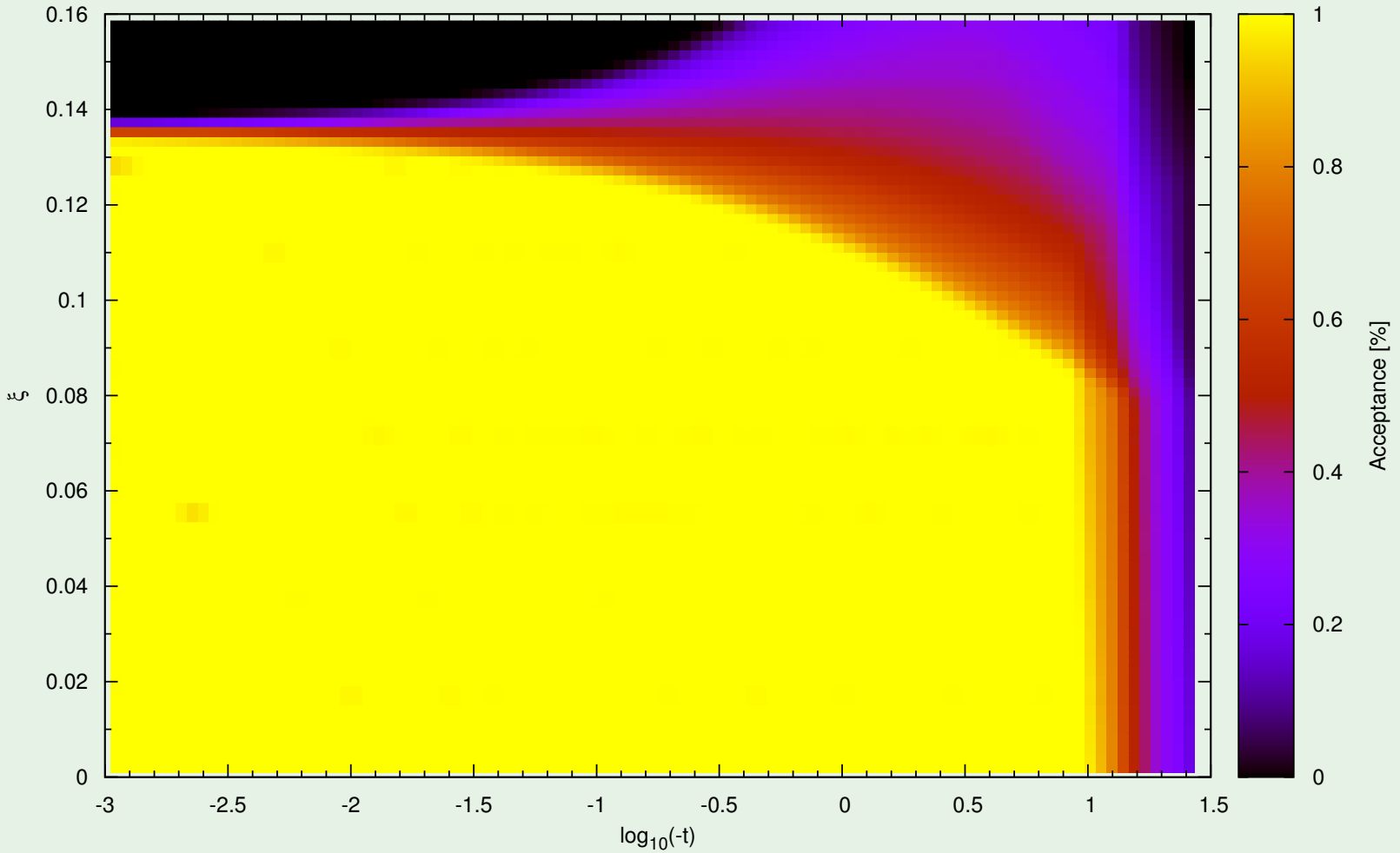
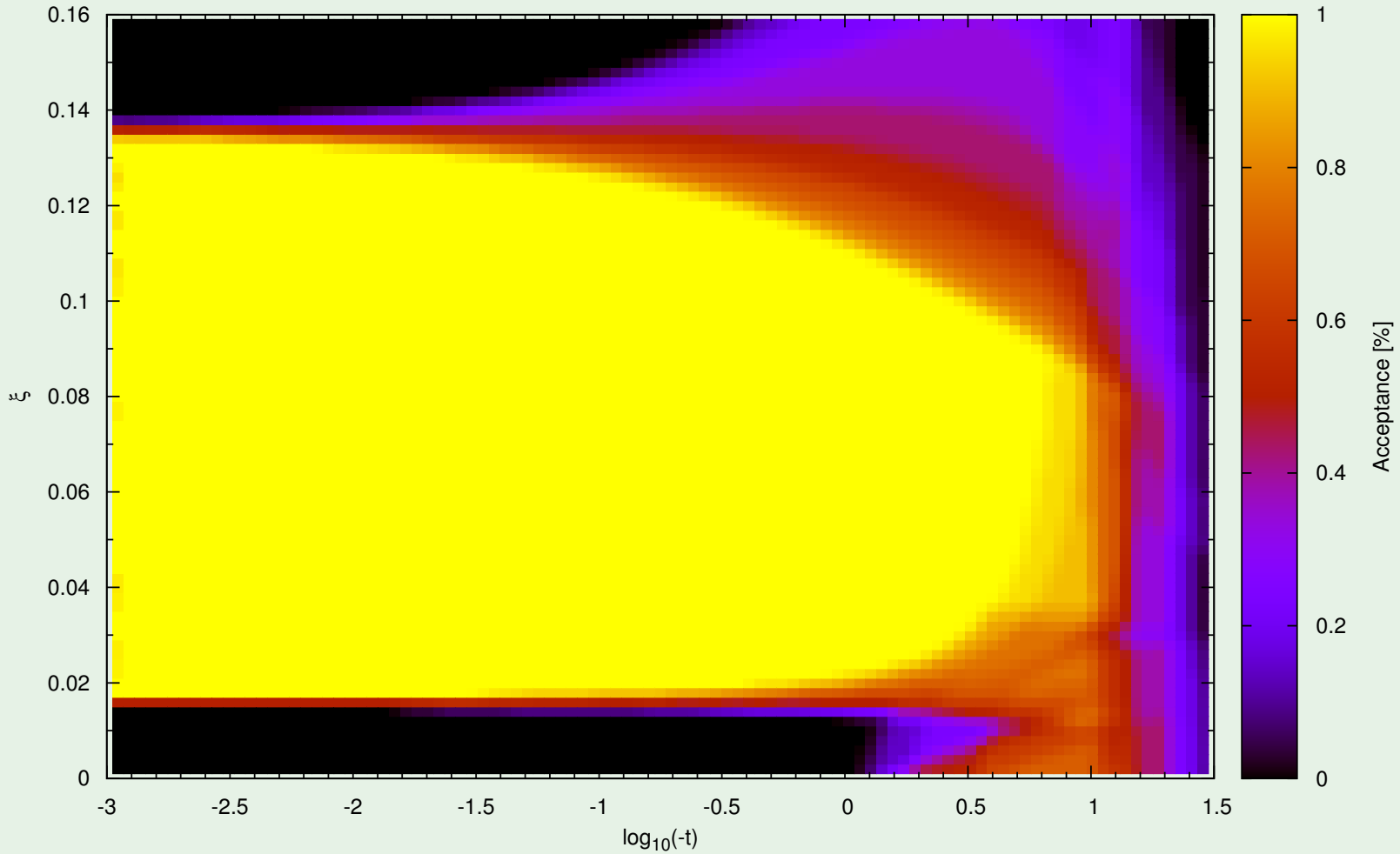
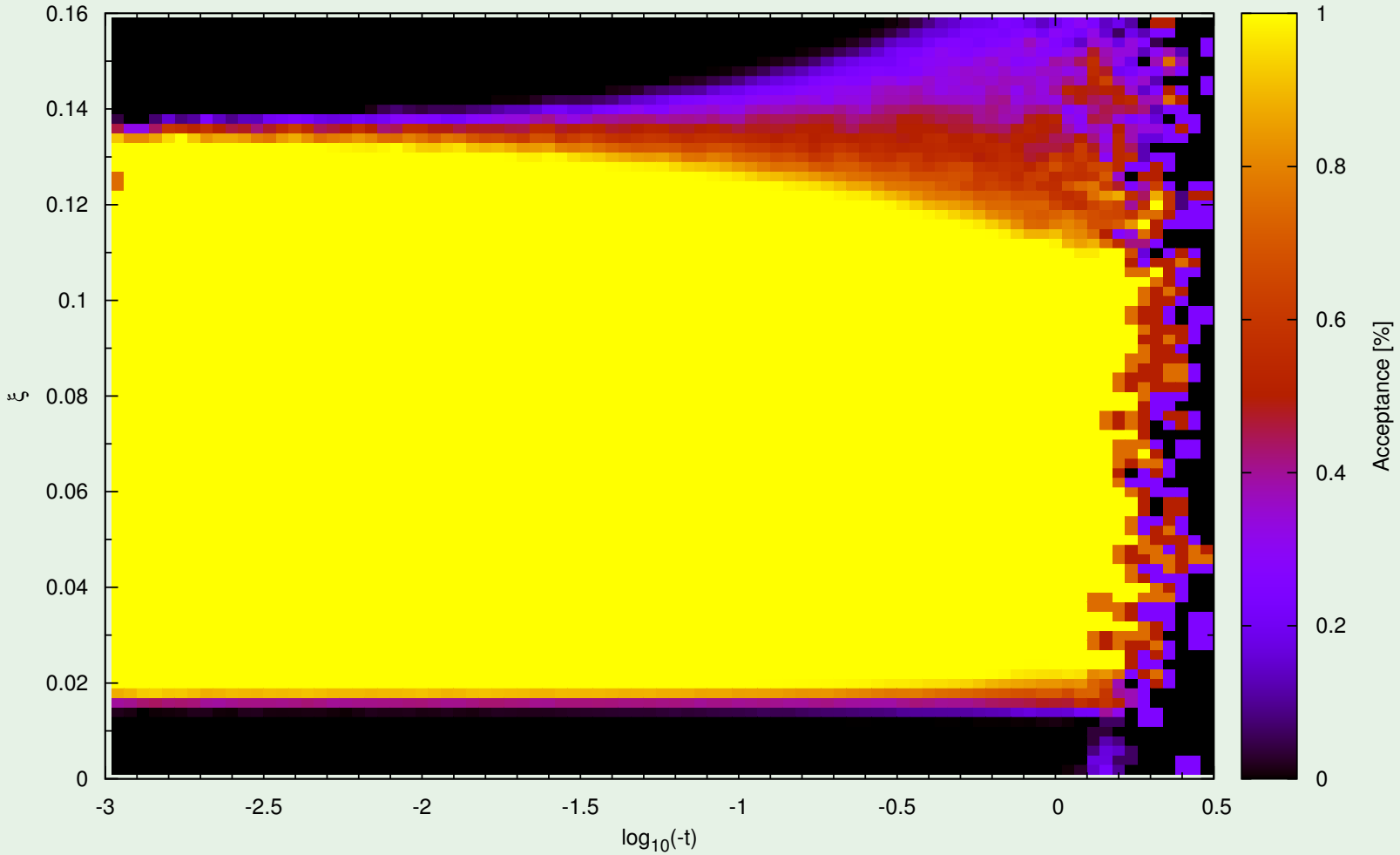
Measurements for whole space inside beamline



Measurements only for $|x| > 2$ mm and $|x| > y$ mm



Data from Pythia process 93



Assumption

- Precision $< 10\ \mu\mathrm{m}$ equivalent to $\frac{10\ \mu\mathrm{m}}{25\ \mathrm{mm}} \simeq 10^{-4}$
- General dependence: $x = x(x_0, x_0', E_{loss})$

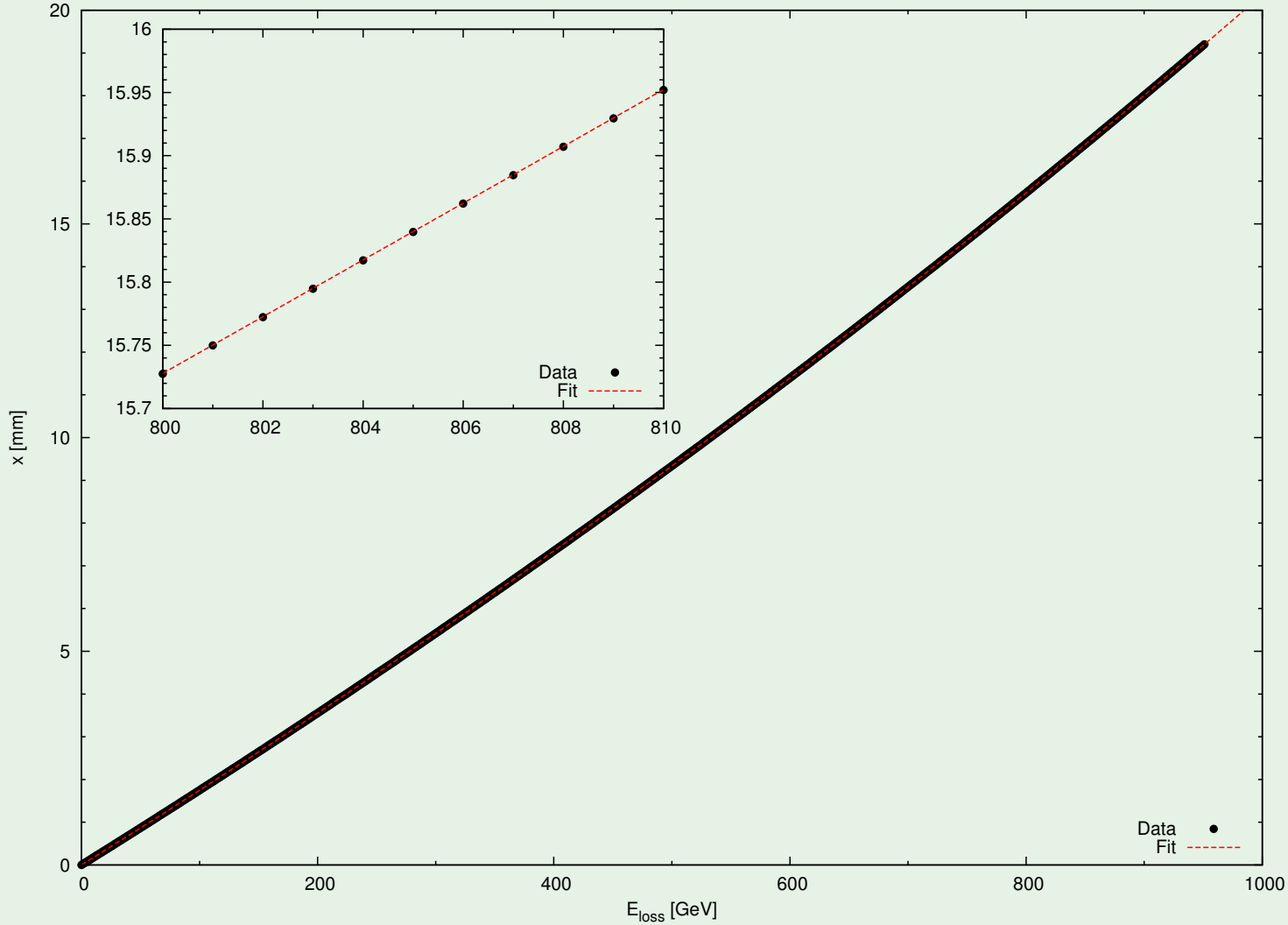
Steps

1. $x(x_0, x_0', E_{loss})\big|_{(x_0, x_0' \text{ fixed})} = x(E_{loss})$
2. $x(x_0, x_0', E_{loss})\big|_{(x_0, E_{loss} \text{ fixed})} = x(x_0')$
3. $x(x_0, x_0', E_{loss})\big|_{(x_0', E_{loss} \text{ fixed})} = x(x_0)$

Parametrization $x(E_{loss})$

$$x(E_{loss}) = c_3 E_{loss}^3 + c_2 E_{loss}^2 + c_1 E_{loss} + c_0$$

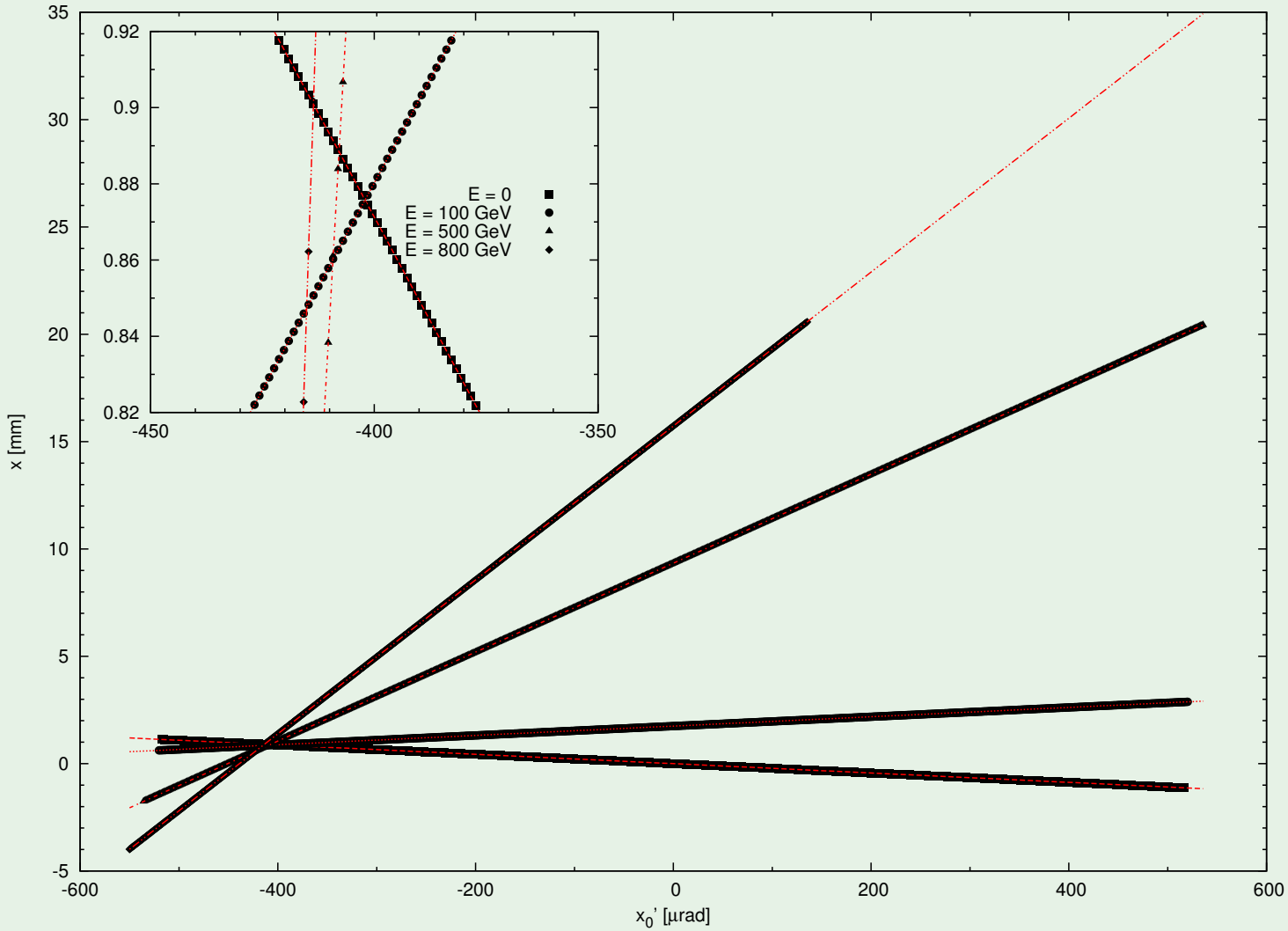
▸ Error



Parametrization $x(x'_0)$

$$x(x'_0) = Ax'_0 + A_0$$

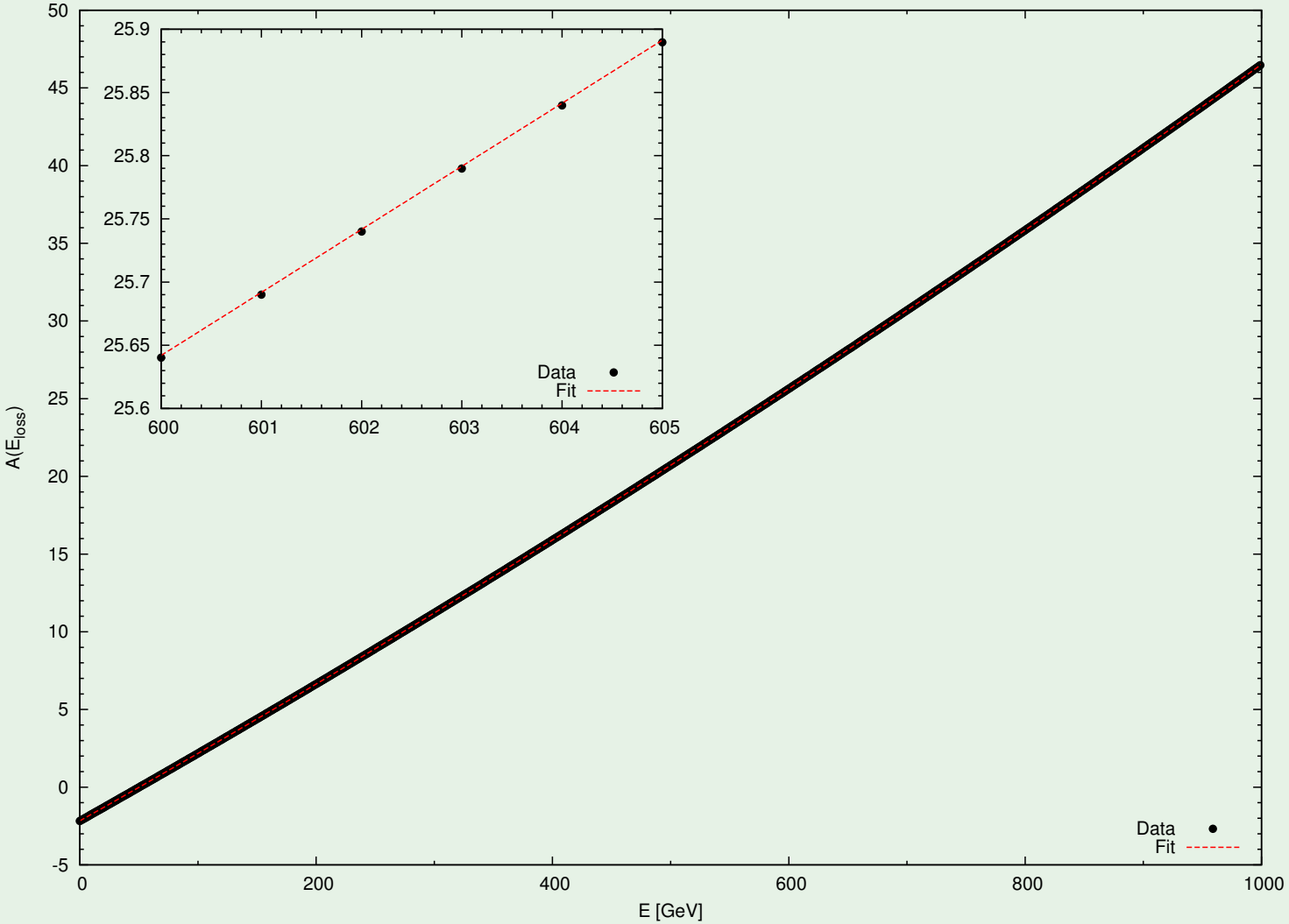
▸ Error



Parametrization $x(x'_0)$

$$A = A(E_{loss}) = a_2 E_{loss}^2 + a_1 E_{loss} + a_0$$

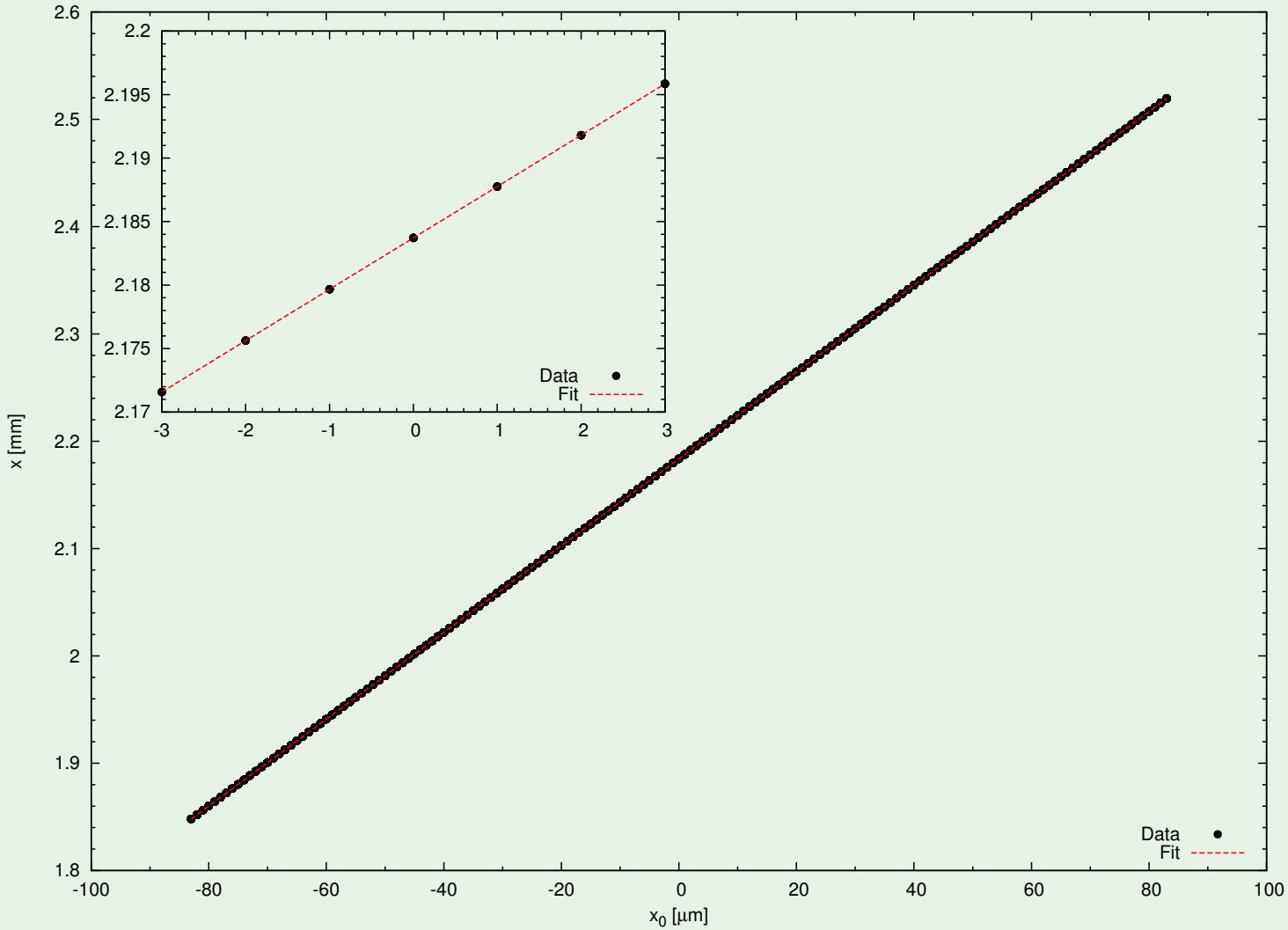
▸ Error



Parametrization $x(x_0)$

$$x(x_0) = Bx_0 + B_0$$

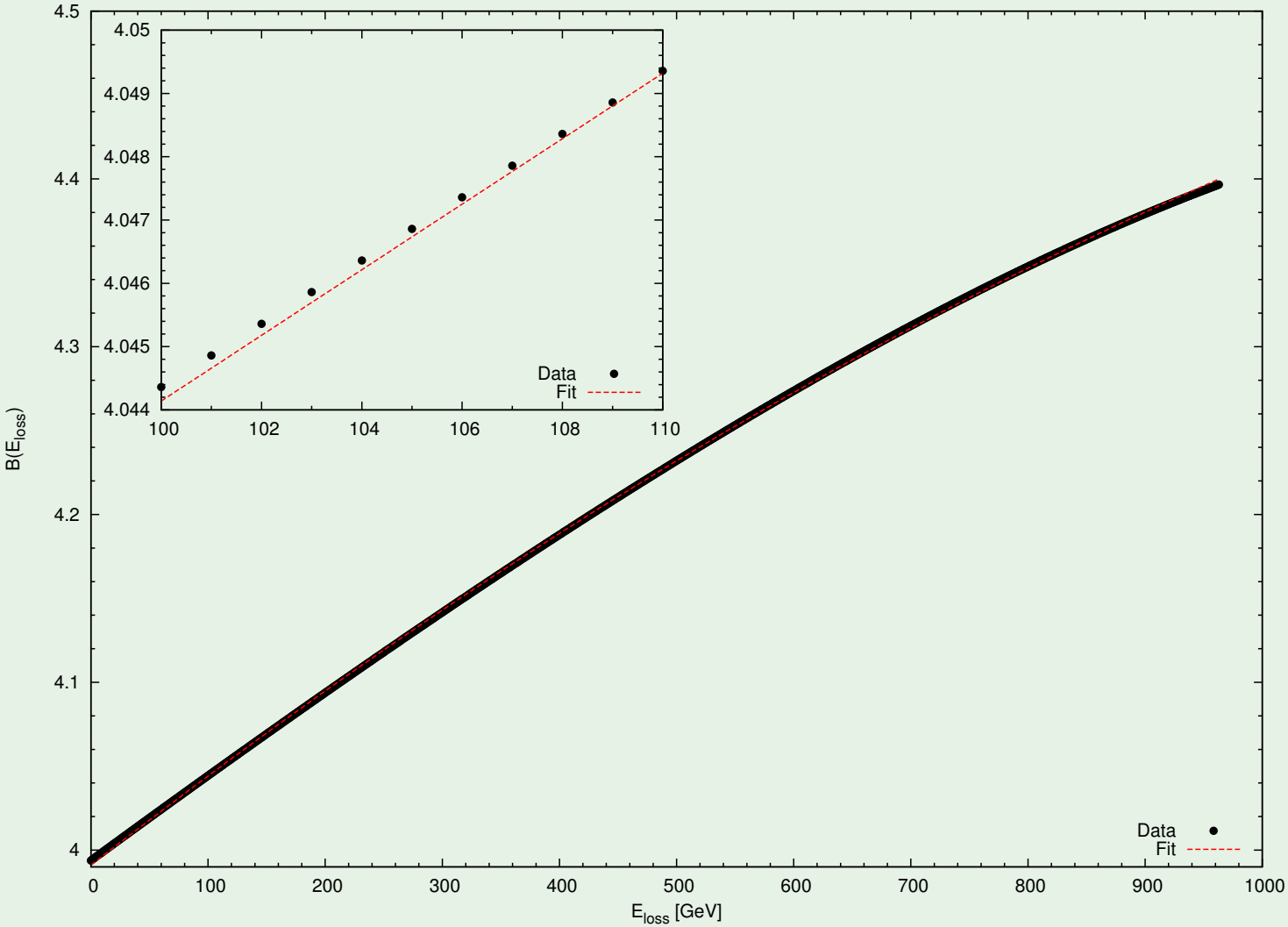
▸ Error



Parametrization $x(x_0)$

$$B = B(E_{loss}) = b_2 E_{loss}^2 + b_1 E_{loss} + b_0$$

▸ Fixed E_{loss} ▸ Error



Parametrization summary

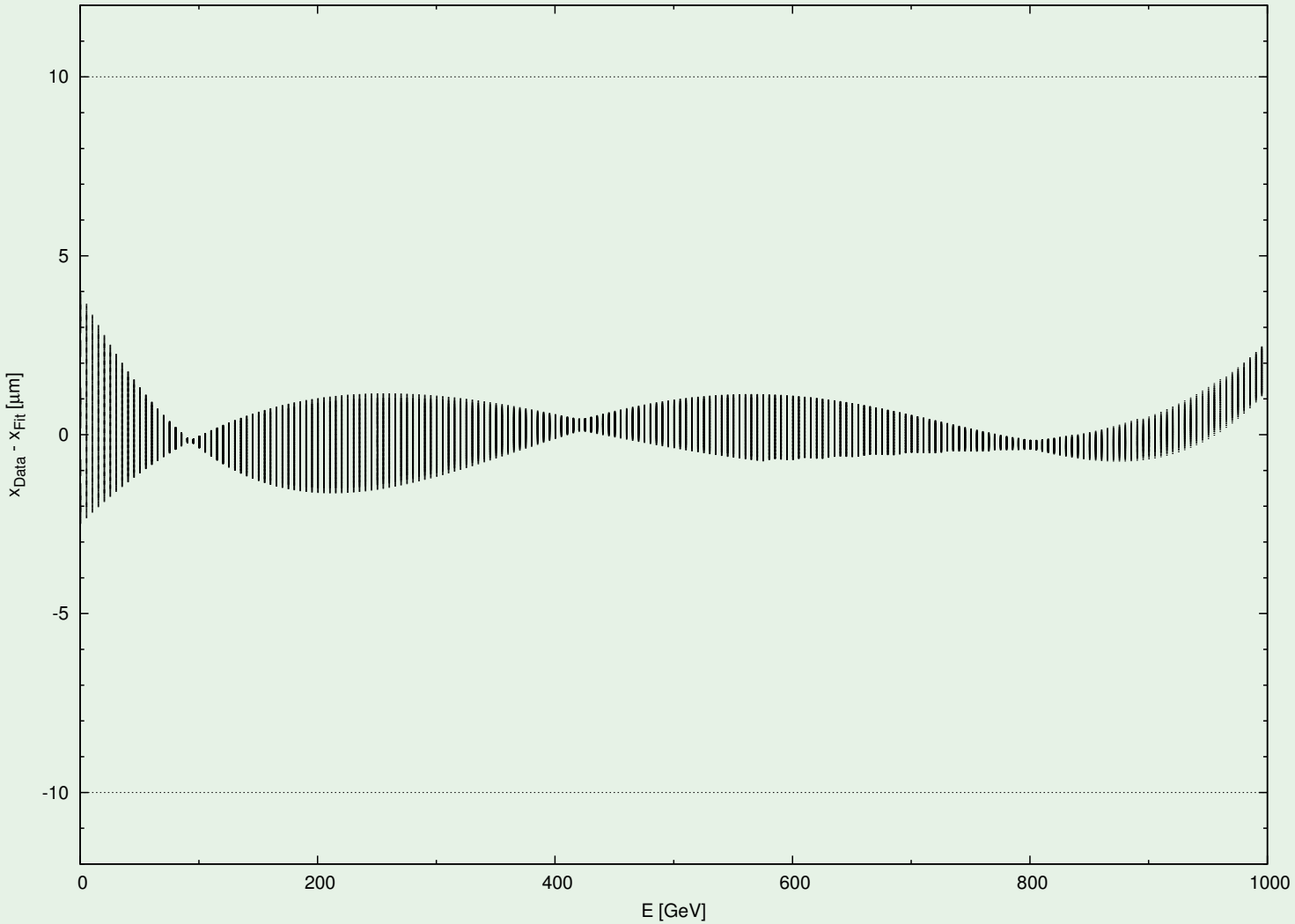
Overall fit

$$x(x_0, x_0', E_{loss}) = B(E_{loss})x_0 + A(E_{loss})x_0' + x(E_{loss})$$

Coefficients

- $x(E_{loss}) = c_3 E_{loss}^3 + c_2 E_{loss}^2 + c_1 E_{loss} + c_0$
- $A(E_{loss}) = a_2 E_{loss}^2 + a_1 E_{loss} + a_0$
- $B(E_{loss}) = b_2 E_{loss}^2 + b_1 E_{loss} + b_0$

Overall fit error



Summary

- What I was doing for 2 months?
  1. Instalation and modifications of FPTrack
  2. Instalation of Pythia and Exhume event generators
  3. Investigating beam profiles at 216 m and 220 m
  4. Investigating acceptances at 220 m for uniform particle distributions and for particles generated by Pythia and Exhume
  5. Parametrizing the dependence of x position in detector on proton kinematics in the IP
- Why?
  1. Beam profiles – tell us how close we can get with detector to the beam
  2. Parametrisation – fast simulation and event reconstruction

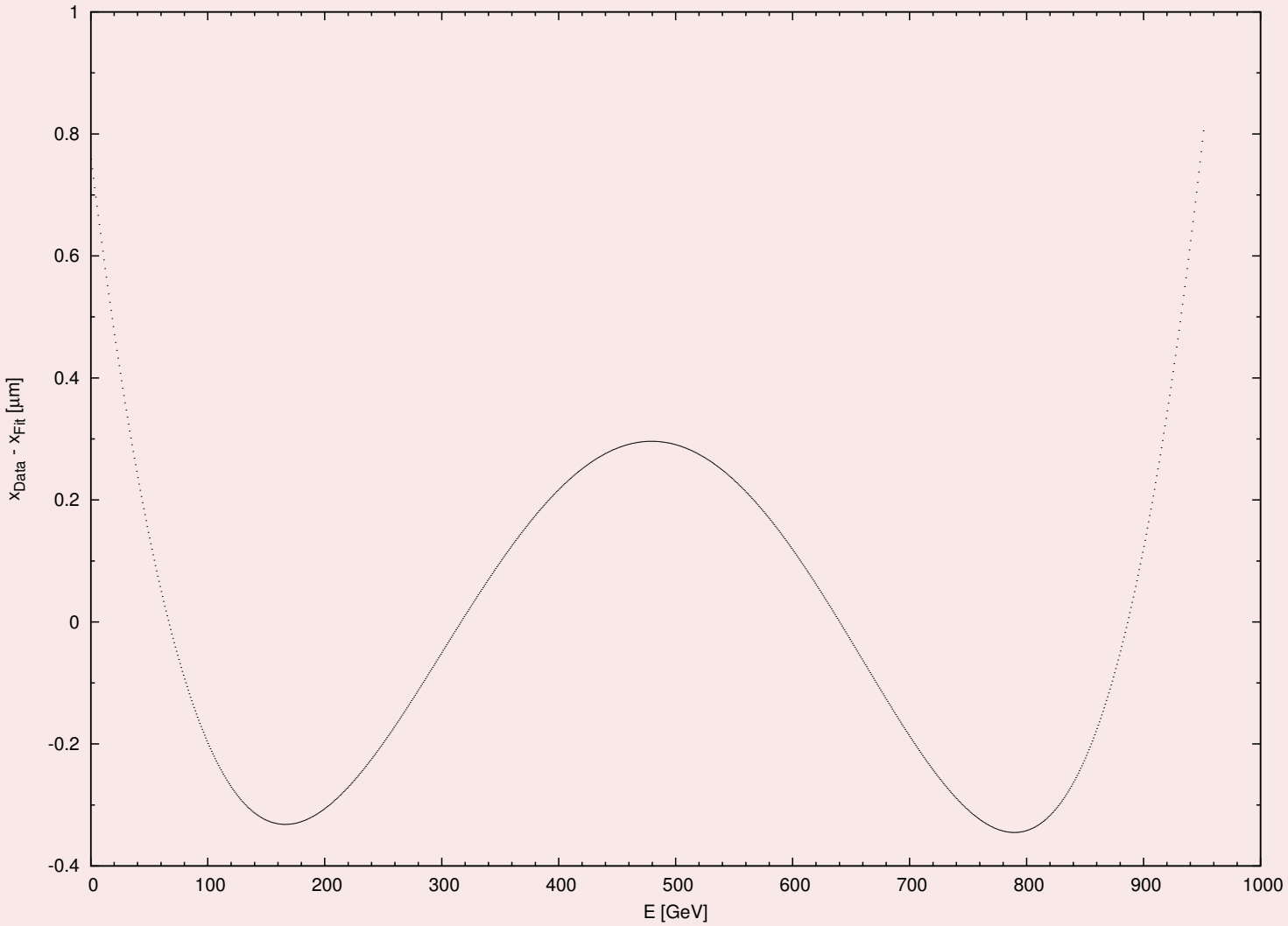
Questions

Supplementary

Parametrization $x(E_{loss})$

$x(E_{loss})$ fit error

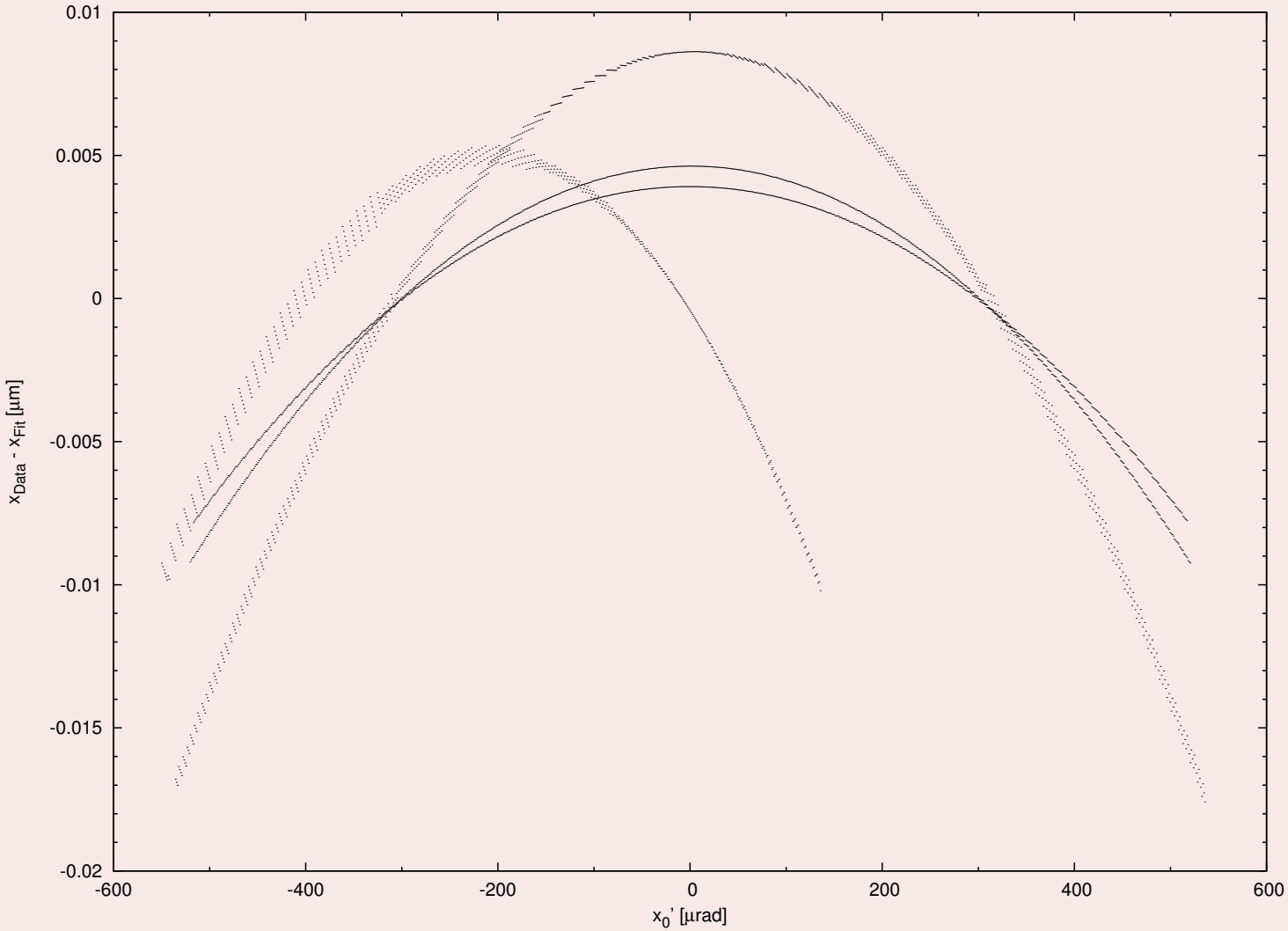
▸ Fit



Parametrization $x(x'_0)$

$x(x'_0)$ fit error

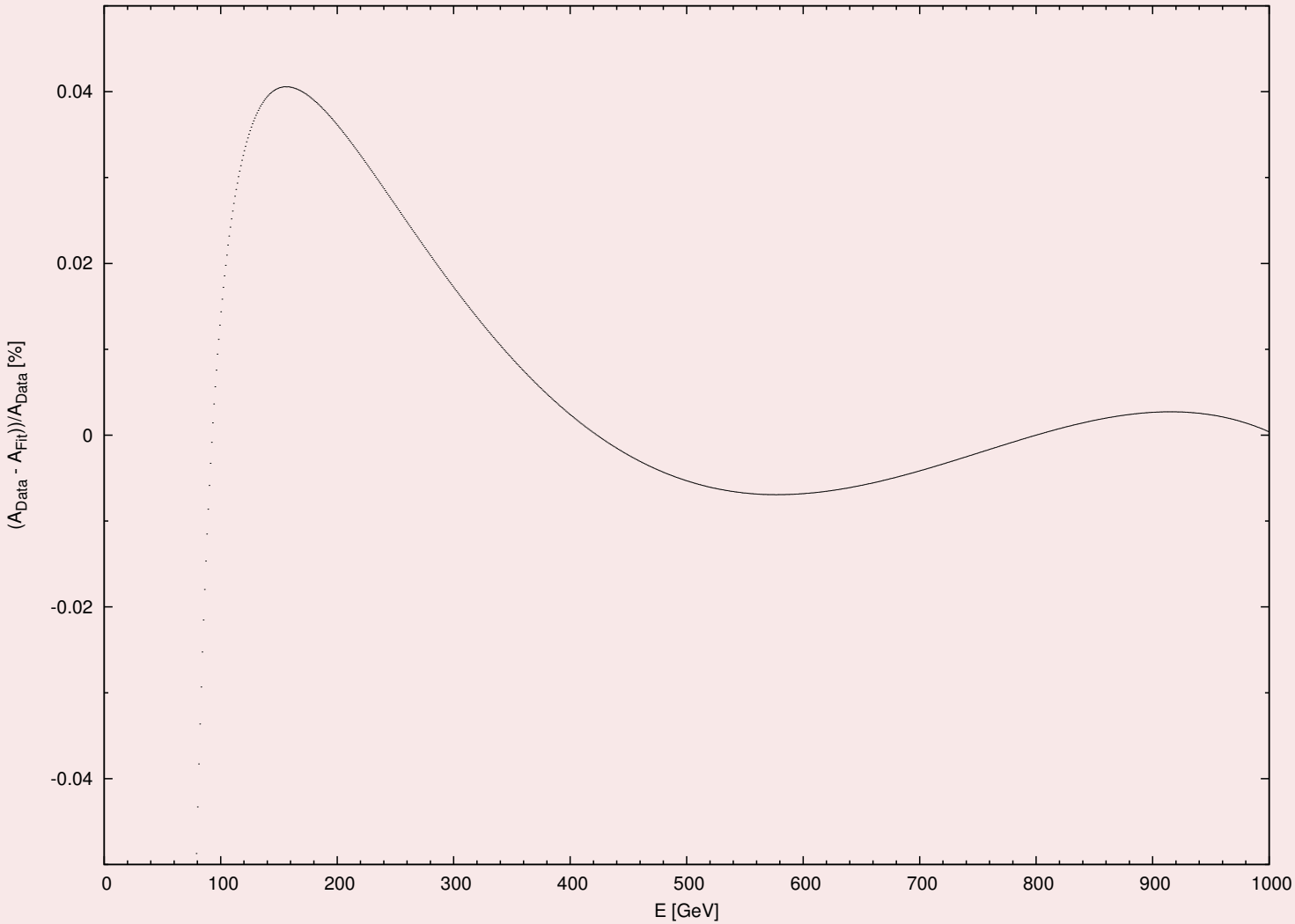
Fit



Parametrization $x(x'_0)$

$A(E_{loss})$ fit error

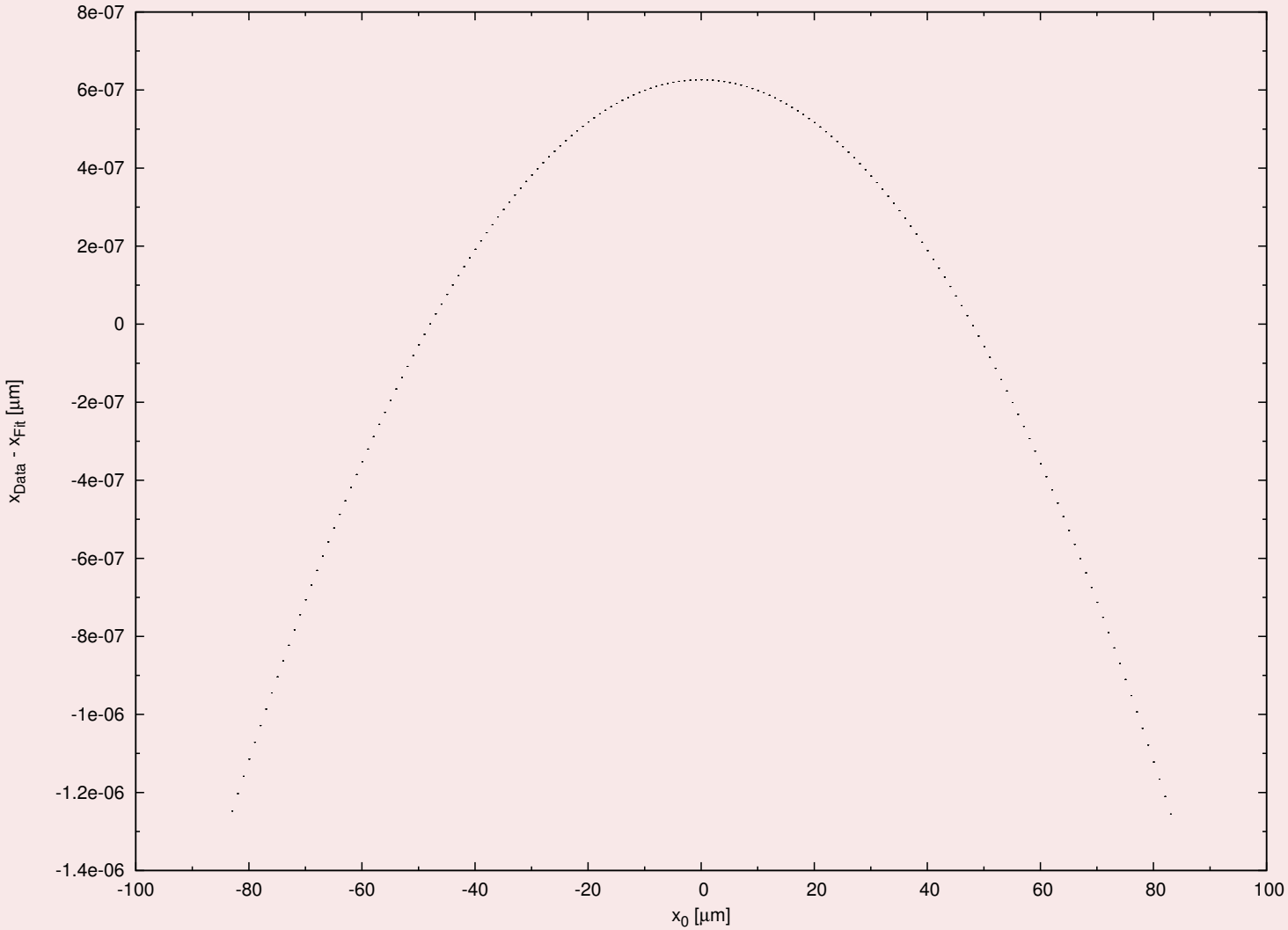
▸ Fit



Parametrization $x(x_0)$

$x(x_0)$ fit error

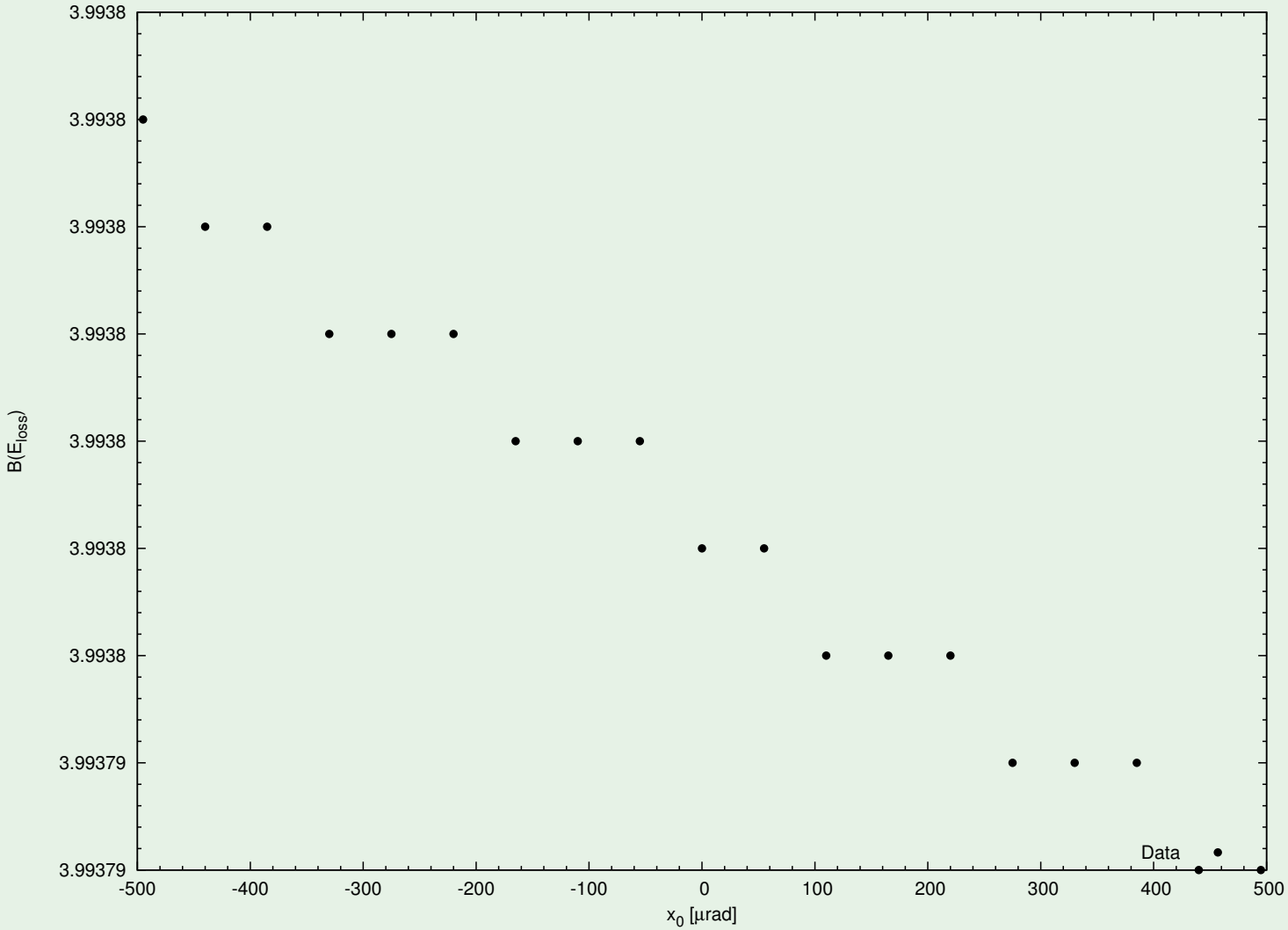
▸ Fit



Parametrization $x(x_0)$

$B = B(x_0') \approx \text{const.}$

Fit



$B(E_{loss})$ fit error

▸ Fit